

CONCLUSION

Evolution of the marine biota on the population and the ecosystem levels is determined by the natural course of natural processes. Evidently, the climatic changes are the most important factor. The excessive pressure of whaling and fisheries, which procure whales, seals, fish and other bioresources (mollusks, algae, etc.), should be regarded as the major anthropogenic factors which influence marine ecosystems in the 20th century. The negative impact of hunting sea animals and large scale fishing, known as overcatch, is internationally recognized by both scientists and specialists.

Any disturbance of the ecological balance in general and high fishing mortality, degraded spawning grounds, deficiency of forage in particular, hinder the rate of natural reproduction. At the moment, all valuable fish species of the northern and the southern seas are more or less affected by this process. This triggered accelerated maturation and growth rate, decrease of the maximum and the mean size of individuals in the populations, rejuvenation of the populations of the majority of commercial species.

By the end of the 20th century, the gray and the ringed seal, the Atlantic walrus and some other polar pinnipeds are being referred to as rare and specially protected. Bad living conditions and absence of proper protection in the southern seas put the marine mammals to the verge of extinction. The fate of colonial and marine birds species is very much the same. They play an especially important role in the organic matter cycle including a trophoparasitary chain.

The most vulnerable sea fish are the short-lived pelagic species. Natural cycles are characteristic of their reproduction. When a poor year and heavy fishery stress coincide in time a population collapses.

The sturgeons are top commercial species in the southern seas. In the north, the Atlantic salmon plays a similar role. The sturgeons cause serious concern, because the irreversible processes take place in the mechanism of their reproduction and this leads to fading of the process of the natural reproduction of the population.

The given analysis demonstrates quite convincingly the general tendency of steady decrease (with rare exceptions) of abundance and catches of practically all commercial fish species at the end of the 20th century. The natural reaction to decrease of reproductive capacities of the given ecosystems was the introduction of the commercial fauna species from the water reservoirs of other continents in the 1950–80s.

Transformation of marine biota species composition as the result of invasion of exotic species, introduction and other anthropogenic factors disrupted the ecosystems. Many exotic species, being ecologically flexible and having high rate of reproduction, develop into numerous populations in new reservoirs and deeply affect species and forage composition

of ecosystems. That is why dubious biological consequences resulting from natural and artificial replacement of vanishing or feeble elements of marine ecosystems need special consideration.

The half a million population of the Kamchatka crab in the coastal zone of the Barents Sea successfully competes with the aboriginal fauna for the same food resources. The Caspian crawfish *Cercopagis* settled down in the Gulf of Finland and spreads in the Baltic Sea gradually forcing the Baltic anchovy and sprat out of their niche. Striped mullet and stone moroco in the Azov Sea gradually supersedes the valuable local fish species in their ecological niches. The outburst of the abundance of the comb jelly, which was brought from the East American waters in the 1980–90s, turned out a disaster for the Black Sea and the Azov Sea basin.

These permanent processes affect all trophic levels from whales, dolphins, birds to many plankton species. Introduction makes some sense in the marine basins with a degraded fishery sector of the ecosystem. But from the biological point of view introduction of new species is not always justified.

Any forms of uncontrolled introduction of exotic biota into natural environments of sea organisms should be stopped. This concerns e.g. export of exotic species with ballast waters of vessels or in the course of introduction of new fish species. Nowadays It is highly hazardous to use new introducers as the balance to exotic species. In order to do so the complex of measures aiming at restoration of the local fish species populations should be realized. The efforts should preferably be focused on the restoration of the abundance of the Black Sea scad and mackerel, which are capable to feed on e.g. *Mnemiopsis* and similar animals.

Search for the ecologically safe and effective methods of dealing with the expansion of the exotic species of fauna is the most important task of natural science and practical workers. Without solving this problem it will be next to impossible to support natural reproduction and artificial rearing of local valuable fish species.

It is expedient to concentrate efforts on the compensating role of aquaculture. The southern basins (the Azov Sea, the North Caspian Sea) may concentration the full cycle artificial rearing of valuable fish species from fish eggs to ready made product (sea as a “big cage”). Rearing of the sturgeon is the most promising branch. Artificial breeding of young fish with subsequent release into natural environment is possible in less favorable conditions of the Barents Sea. Programs of mariculture development in the seas of Russia should also be elaborated with consideration of interrelations in ecosystems, so that not to upset them. The emphasis should be laid upon restoration of the aboriginal fauna species. The task of applied and fundamental science is to broaden the spectrum of studies of marine animals genetics, selection and adaptability to changing environment.

A series of other commercial practices is known to have negative impact on benthic communities. The major factors are trawling of fish and invertebrates, mass transport of ground during dredging of access canals in shallow waters and chemical contamination in general. Undifferentiated approach to the standardization of the anthropogenic pressure on the marine ecosystems may lead either to the discrediting of useful ideas and methods or countless economic losses.

Thus, at this stage, the objectives of marine bioresources preservation may be determined as follows:

- Establishment of the state program of biological research of the European seas of Russia (the structure and the functioning of the marine ecosystems);
- Restoration of the state ecological monitoring of the marine environment and biota;
- Providing of the effective control of catches and fishery management, restoration of the fishery statistics;
- Introduction of the state control over adaptation and introduction of the new items;
- Development of the artificial restoration of fishes, the pasture rearing of fishes and marine culture.

With reference to this problems we should say that at the moment the attention to the fundamental problems of marine biology falls behind the modern requirements. For instance, the biological section of the Federal Program "World Ocean" traditionally focuses on the resources and the role of the relevant governmental agency, while the role allotted to the academic science is not defined precisely.

Thus, development of civilization against the background of global natural changes resulted in decrease of key species abundance and change of their ratio by the beginning of the 21st century. It was followed by modifications of the general structure and cycle of ecosystems. These changes have a uniform outcome, though causes are different. The detected changes are hardly the result of a single factor, e.g. pollution.

Anthropogenic pressure, consequently, causes decrease of production of the ultimate element of the trophic chain, including valuable fish species, birds and marine mammals. The reaction of the ecosystem to anthropogenic pressure is lowering of the energetic balance level because of the changes in energy fluxes in trophic chains and disruption of the top elements of the pyramid. Unfortunately, all attempts to restore original state of the ecosystem and to recover abundance of traditional objects of fishery do not reach the desired objectives.

The strategy of the marine nature protection should be based on progressive development and introduction of ecologically pure technologies in all spheres of human activities, which will ensure a breakthrough reduction of harmful substances input into estuarine and marine ecosystems. Our goal is to join our efforts for ecosystem forecasting, in order to chose the best ways of marine bioresources exploitation which will be our input into development of terrestrial and marine economic practices in Russia in the 21st century.

In conclusion we would like to point out, that this extremely complicated question has not been exhausted. We are sure that Russia must not, at least, waste its biological marine resources. Countries where the diet comprises a lot of sea food have the longest life expectancy. That is why the role of fundamental biological research in elaboration of theory of functioning of marine ecosystems should match importance and extent of the given task.